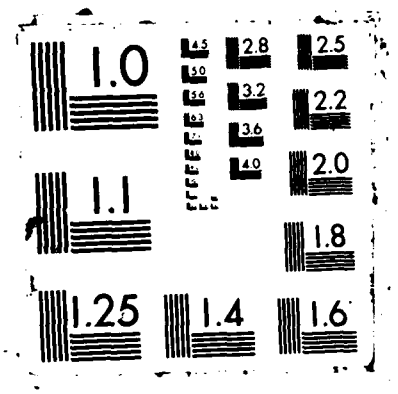
AD-A183 458 FINAL REPORT ON CONTRACT N00014-75-C-0540(U) RUTGERS - 1/1
THE STATE UNIV PISCATAWAY NJ HIGH PRESSURE MATERIALS
RESEARCH LAB K D PAE 15 JUL 87 N00014-75-C-0540
UNCLASSIFIED F/G 11/9 NL


1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
4.5
5.0
5.6
6.3

OFFICE OF NAVAL RESEARCH

Contract N00014-75-C-0540

Task o. NR 092-002X

FINAL REPORT

By

Kook D. Pae

High Pressure Materials Research Laboratory
Rutgers University
Piscataway, NJ 08855-0909

July 15, 1987

INTRODUCTION

A great deal of research work and significant achievements have been made on the effects of hydrostatic pressure on various aspects of physical and mechanical properties of polymers. The areas of interests included high pressure x-ray studies, high pressure DTA stduies, high pressure effects on mechanical properties, pressure-volume-temperature relations, high pressure crystallization, and high pressure effects on piezoelectricity and pyroelectricity. The results of the research have been published in ONR Technical Reports and numerous journal publications as listed below.

PERSONNEL

Coprincipal Investigators

Professor K. D. Pae

Professor B. A. Newman

Professor J. I. Scheinbeim

Ph. D. Students

T. P. Sham

C. H. Yoon

K. T. Chung

D. L. Questad

K. Vijayan

R. W. Renfree

P. K. Chen

K. Tagashira

TECHNICAL REPORTS

Technical Report No. 1
The Structure and Properties of Crystalline Polymers at High Pressure.

Technical Report No. 2
The Effects of Molecular Weight on the Pressure-Dependent Mechanical Properties of Polypropylene.

Technical Report No. 3
A Pressure Calibration for the Diamond-Anvil Cell in the Range 0-15 Kbars.

Technical Report No. 4
An X-ray Study of Polyethylene at Pressures up to 14,000 kg/sq cm at 298 K.

Technical Report No. 5
The Macroscopic Yielding Behavior of Polymers in Multiaxial Stress Fields.

Technical Report No. 6
High Pressure X-Ray Studies of Polymers. I.
Pressure Calibration for the Diamond-Anvil Cell in the Range 0-15 Kbars.

Technical Report No. 7
High Pressure X-Ray Studies of Polymers. II.
Variations of Pressure with Temperature in the Diamond-Anvil Cell.

Technical Report No. 8
High Pressure X-Ray Studies of Polymers. III.
Phase Transformation of Polyethylene.

Technical Report No. 9
Effects of Hydrostatic Pressure on Shear Deformation of Polypropylene and Polyoxymethylene.

Technical Report No. 10
High Pressure X-Ray Studies of Nylon 11.

Technical Report No. 11
A High Pressure X-Ray Study of Poly(vinylidene fluoride), Phase II.

Technical Report No. 12
High Pressure Crystallization of Poly(vinylidene fluoride).

Technical Report No. 13
X-Ray High Pressure Study of Poly(vinylidene fluoride).

Technical Report No. 14
The Dependence of the Piezoelectric Response of Poly(vinylidene fluoride) on Phase I Volume Fraction.

Technical Report No. 15
Piezoelectric Activity and Field-induced Crystal Structure Transitions in Poled Poly(vinylidene fluoride) Films.

Technical Report No. 16
Pressure Dependence of Glass Transition and Related Properties of Solithane 113 Elastomer.

Technical Report No. 17
Pressure-Volume-Temperature Studies of a Polyuethane Elastomer.

Technical Report No. 18
The Pressure Dependence of the Pyroelectric Response of Poly (vinylidene fluoride) Films.

Technical Report No. 19
Piezoelectricity in Nylon 11.

Technical Report No. 20
Ferroelectric Hysteresis Effects in Poly(vinylidene fluoride) Films.

Technical Report No. 21
Piezoelectric and Pyroelectric Properties of Poly(vinylidene fluoride) Films at High Hydrostatic Pressure.

Technical Report No. 22
Viscoplastic Behavior of a Glass at High Pressure.

Technical Report No. 23
The Poling Field and Draw Dependence of the Piezoelectric and Pyroelectric Response of Pressure Quenched Phase I Poly-(vinylidene fluoride) Films.

Technical Report No. 24
Polarization Mechanisms in Phase II Poly(vinylidene fluoride) Films.

Technical Report No. 25
Mechanical and Physical Properties of Poly(vinylidene fluoride) at High Pressures and Temperatures.

Technical Report No. 26
High Pressure Melting and Crystallization of Nylon 11.

PAPERS PUBLISHED

1. "An X-Ray Studies of Polyethylene at Pressures to 14,000 kg/sq cm at 298 K," J. Mat. Sci., 12,771(1977)(Coauthors T. P. Sham and B. A. Newman).

2. "The Macroscopic Yielding Behavior of Polymers in Multiaxial stress Fields, J. Mat. Sci., 12, 1209(1977).

3. "High Pressure X-Ray Studies of Polymers, Part I: Pressure Calibration for the Diamond Anvil Cell in the Range 0-15 kbars," J. Mat. Sci., 12, 1064(1977)(Coauthos B. A. Newman and T. P. Sham).

4. "High Pressure X-Ray Studies of Polymers, Part II: Variation of Pressure with Temperature in the Diamond Anvil Cell," J. Mat. Sci., 12, 1697(1977)(Coauthors B. A. Newman and T. P. Sham).

5. "High Pressure X-Ray Studies of POlymers, Part III: Phase Transformation of Polyethylene," J. Mat. Sci., 12, 1793(1977) (Coauthors B. A. Newman and T. P. Sham).

6. "High Pressure X-Ray Studies of Nylon 11," J. Appl. Phys., 48, 4092(1977)(Coauthors B. A. Newman and T. P. Sham).

7. "High Pressure X-Ray Studies of Polymers," Proc. 6th Int. Conf. on High Pressure, Eds. K. D. Timmerhaus and M. S. Barber, Plenum Press, 1977, p. 173(Coauthors B. A. Newman and T. P. Sham).

8. "High Pressure Crystallization of Poly(vinylidene fluoride)," J. Appl. Phys., 50, 4399(1979)(Coauthors J. Scheinbeim and C. Nakafuku, and B. A. Newman).

9. "X-Ray High Pressure Study of Poly(vinyliene fluoride)," J. Mat. Sci., 14, Coauthors B. A. Newman and C. H. Yoon).

10. "Piezoelectric Activity and Field-Induced Crystal Structure Transition in Poled Poly(vinylidene fluoride) Films," J. Appl. Phys., 50, 6069(1979)(Coauthors B. A. Newman, C. H. Yoon, and J. I. Scheinbeim).

11. "The Dependence of the Piezoelectric Response of Poly(vinylidene fluoride) on Phase I Volume Fraction," J. Appl. Phys., 50, 6101(1979)(Coauthors J. I. Scheinbeim, K. T. Chung, and B. A. Newman).

12. "Pressure Dependence of the Glass Transition and Related Properties of Solithane 113 Elastomer," J. Appl. Phys., 51, 5100(1980)(Coauthors D. L. Questad, B. A. Newman, and J. I. Scheinbeim).

13. "The Pressure Dependence of the Pyroelectric Response of Poly(vinylidene fluoride) Films," J. Appl. Phys., 51, 5106(Coauthors J. I. Scheinbeim, K. T. Chung, and B. A. Newman).

14. "Ferroelectric Hysteresis effects of Poly(vinylidene fluoride) Films," J Appl. Phys., 51, 5156(1980)(Coauthors J. I. Scheinbeim, C. H. Yoon, and B. A. Newman).

15. "Piezoelectricity in Nylon 11," J. Appl. Phys., 51, 5161 (1980)(Coauthors B. A. Newman, P. Chen, and J. I. Scheinbeim).

16. "Poling Time Dependence of the Field-Induced Phase Transition and Piezoelectric Response of Poly(vinylidene fluoride) Films," J. Polym. Sci., Phys. Ed., 18, 2271(1980)(Coauthors J. I. Scheinbeim, C. H. Yoon, and B. A. Newman).

17. "Mechanical Properties of an Elastomer at High Pressures," Proc. Inter-American Conf. Mat. Tech., Mexico City, 1981, p.717 (Coauthors D. L. Questad and K. Anam).

18. "Viscoplastic Behavior of a Glass at High Pressures," J. Appl. Phys., 52, 5977(1981)(Coauthors D. L. Questad, J. I. Scheinbeim, and B. A. Newman).

19. "Piezoelectric and Pyroelectric Properties of Poly(vinylidene fluoride) Films at High hydrostatic Pressure," Ferroelectrics, 32, 135(1981)(Coauthors B. A. Newman, K. T. Chung, and J. I. Scheinbeim).

20. "The Pressure and Temperature Dependence of Piezoelectric Response of Poled Unoriented Phase I Poly(vinylidene fluoride)," J. Appl. Phys., 53, 6557(1982)(Coauthors K. T. Chung, B. A. Newman, and J. I. Scheinbeim).

21. "Pressure-Volume-Temperature Studies of a Polyurethane Elastomer," J. Appl. Phys., 53, 6578(1982)(Coauthors D. L. Questad, J. I. Scheinbeim, and B. A. Newman).

22. Piezoelectric Polymers, Eds. K. D. Pae and Y. Wada, Proc. the U.S.-Japan Cooperative Seminar on Piezoelectric Polymers, Honolulu, Hawaii; Ferroelectrics, 15, pp. 1-354, 1984.

23. "Mechanical and Physical Properties of Poly(vinylidene fluoride) at High Pressures and Temperatures," Ferroelectrics, 57, 249(1984)(Coauthors K. Vijayan, R. W. Renfree, K. T. Chung, J. I. Scheinbeim, and B. A. Newman).

24. "High Pressure Melting and Crystallization of Nylon 11," J. Mat. Sci., 20, 1753(1985)(Coauhtors P. K. Chen, B. A. Newman, and J. I. Scheinbeim).

PH.D. THESES PRODUCED

1. T. P. Sham, High Pressure X-Ray Diffraction Studies of Crystalline polymers, 1977.

2. C. H. Yoon, Ferroelectric Hysteresis Effects of Poly-(vinylidene fluoride) Films, 1979.

3. K. T. Chung, Piezoelectric and Pyroelectric Properties of Poly(vinylidene fluoride at High pressures, 1980.

4. D. L. Questad, The Effects of Pressure on the Physical and Mechanical Properties of Solithane 113 Elastomer, 1981.

5. P. K. Chen, Piezoelectricity, Structure, and Morphology of Nylon Films, 1982.

6. K. Tagashira, High Pressure X-Ray Studies of Poly(trans-1,4-butadiene), 1984.

END

9-87

DTIC